Fisheries and Oceans Science | Pêches et Océans Sciences

CSAS | *SCÉS*

Canadian Stock Assessment Secretariat | **Secrétariat canadien pour l'évaluation des stocks**

Research Document 2000/045 | **Document de recherche 2000/045**

Not to be cited without
Permission of the authors [1] | Ne pas citer sans
autorisation des auteurs [1]

The stock status of Atlantic salmon (*Salmo salar* L.) in Big Brook (Michaels River), Labrador, 1999

by

D. G. Reddin and P. B. Short

Science Branch
Department of Fisheries and Oceans
P. O. Box 5667
St. John's, Newfoundland A1C 5X1

[1] This series documents the scientific basis for the evaluation of fisheries resources in Canada. As such, it addresses the issues of the day in the time frames required and the documents it contains are not intended as definitive statements on the subjects addressed but rather as progress reports on ongoing investigations.

[1] La présente série documente les bases scientifiques des évaluations des ressources halieutiques du Canada. Elle traite des problèmes courants selon les échéanciers dictés. Les documents qu'elle contient ne doivent pas être considérés comme des énoncés définitifs sur les sujets traités, mais plutôt comme des rapports d'étape sur les études en cours.

Research documents are produced in the official language in which they are provided to the Secretariat.

Les documents de recherche sont publiés dans la langue officielle utilisée dans le manuscrit envoyé au Secrétariat.

This document is available on the Internet at:

Ce document est disponible sur l'Internet à:

http://www.dfo-mpo.gc.ca/csas/

ISSN 1480-4883
Ottawa, 2000

Canada

102-02315/

Abstract

The status of the Atlantic salmon (*Salmo salar* L.) stock in Big Brook (also known as Michaels River), Labrador in 1999 was determined using counting fence data, samples collected in the angling fishery, and records of angling mortalities. The stock assessment was conducted in relation to the closure of the Atlantic salmon commercial fishery in Labrador in 1998. Also, this is the second assessment of a northern Labrador salmon stock. In 1999, total returns to Big Brook, adjusted for a non-operational period of counting fence due to high water, were 737 small and 180 large salmon. Small and large salmon made up 80.4 and 19.6%, respectively of returns to the river. The number of spawners adjusted for angling mortalities were 684 small and 166 large salmon. The egg deposition required for conservation for Big Brook is 5.294 x 10^3 eggs using information from a river survey conducted by Murphy (1973) and the salmon conservation requirement of 240 eggs per m^2. The egg requirement converts to 1,780 small and 439 large salmon. In 1999, the proportion achieved of the conservation egg requirements was 38% (95^{th} confidence intervals 27 to 51%). There were 50 brook trout but no charr observed at the counting fence.

Résumé

L'état du stock de saumon atlantique (*Salmo salar* L.) de Big Brook (aussi connu sous le nom de Michaels River), au Labrador, en 1999 a été déterminé d'après des données recueillies à une barrière de dénombrement, des échantillons des prises sportives et des renseignements sur la mortalité par pêche sportive. Deuxième évaluation d'un stock de saumon du nord du Labrador, cette évaluation a été réalisée dans le contexte de la fermeture de la pêche commerciale du saumon atlantique au Labrador en 1998. En corrigeant pour tenir compte d'une période où la barrière de dénombrement ne fonctionnait pas en raison de hautes eaux, on estime qu'en 1999, 737 petits et 180 gros saumons ont remonté dans Big Brook, soit respectivement 80,4 et 19,6 % de la remonte dans la rivière. Le nombre de géniteurs, corrigé pour tenir compte de la mortalité par pêche sportive, était de 684 petits et de 166 gros saumons. D'après l'information recueillie au cours d'un relevé du cours d'eau effectué par Murphy (1973) et les 240 œufs par m^2 nécessaires pour répondre aux besoins de conservation du saumon, la ponte requise pour satisfaire à ces besoins dans Big Brook se chiffre à 5,294 x 10^3 œufs, ce qui nécessiterait la présence de 1 780 petits et de 439 gros saumons. En 1999, ces besoins ont été comblés dans une proportion de 38 % (intervalle de confiance de 0,95 allant de 27 à 51 %). Cinquante ombles de fontaine ont été observés à la barrière de dénombrement, mais aucun omble chevalier.

INTRODUCTION

Big Brook (also known as Michaels River) is located in northern Labrador in Salmon Fishing Area 1 (SFA 1) and flows into Byron Bay near Red Rock Point just to the north of Cape Rouge at 54^0 41' N 57^0 47' W (Anderson 1985) (Fig. 1). The mouth of the river is protected by a high, sandy beach, which forms a lagoon that is approximately 1.5 km long. Big Brook has a drainage area of 793 km^2 and a total stream length (including measured tributaries) of 200 km (Murphy 1973). There is a sports fishing camp on the river which entertains guests for varying periods of time annually and the river is also periodically visited by fly-in anglers. The entire watershed is accessible to migrating fish. Anadromous Atlantic salmon (*Salmo salar* L.), Arctic charr (*Salvelinus alpinus* L.), and both sea-run and resident brook trout (*Salmo trutta* L.) have been reported in the system (Anderson 1985).

In 1992, several major changes were introduced to the management of Atlantic salmon in Newfoundland and Labrador. A five-year moratorium was placed on commercial salmon fishing in the island portion of the province, quotas for the Labrador commercial fishery, first introduced in 1990, were reduced and a voluntary retirement of commercial salmon licences was instituted for all of the province. In 1998, the commercial fishery in Labrador was closed and fishermen were offered a buyout which most accepted. In 1999, a food fishery of 10 tonnes was available for members of the Labrador Inuit Association including catches in Lake Melville, which is also in SFA 1. The West Greenland commercial salmon fishery which was closed for the 1993 and 1994 fishing seasons but was open again in 1995-97. Although no tagging studies have documented the distribution of Big Brook salmon at sea, some Big Brook multi-sea winter salmon may be caught in the Greenland fishery similar to other Labrador stocks (Pratt et al. 1974). In 1999, there was no marine fishery (food or commercial) in the vicinity of Big Brook.

In the angling fishery, in 1992 and 1993, a quota on the number of fish that could be retained was introduced in each SFA. The quota was assigned for an entire SFA and was not administered on an individual river basis. Only hook-and-release fishing was permitted after the quota was caught. In 1994, quotas for the angling fishery were eliminated. In place of quotas, for Labrador, the season bag limit for retained salmon was lowered from eight to six fish, only two of which could be large salmon. In 1995 and 1996, the season bag limit for the angling fishery remained at six fish but only one large salmon could be retained. In 1999, the angling fishery was restricted to a seasonal limit of four salmon retained, one of which could be large, and a daily limit of four salmon hooked-and-released.

In 1999, a salmon assessment project was conducted on Big Brook. The main focus of this project, conducted in collaboration with Atlantic Sports Fishing Inc. (Mr. W. Bennett), was to assess the population of salmon in a northern Labrador river. The first counting facility to be installed in a river in SFA 1 in recent years was on Big Brook in 1997. Thus, Big Brook is one of the few Atlantic salmon rivers in Labrador for which quantitative data are available. In this paper, the stock status of the Big Brook salmon population in 1999 is examined.

METHODS

Angling and commercial fisheries data

Catch and effort data from the angling fishery in Big Brook were collected by Department of Fisheries and Oceans (DFO) enforcement staff in conjunction with angling reports submitted by commercial sports camp operators and processed by DFO Science Branch. DFO angling statistics for Big Brook include salmon caught at the fish camp and by non-camp anglers. In 1997 and 1999, angling catches for Big Brook took place below the counting fence where the majority of salmon were reported to have been caught (pers. comm., Mr. J. Small). Procedures for the collection and compilation of angling fishery data are described by Ash and O'Connell (1987).

In 1994, a new system, viz. the License Stub Return System (LSRS) was initiated for collecting angling statistics in Newfoundland and Labrador. It is based on attaching to the provincial angling licence a detachable stub upon which the angler can record details of where and when fished, and the numbers of salmon caught and released (O'Connell et al. 1998). Because of concerns over a lack of comparability of DFO angling statistics and the LSRS data, DFO data will continue to be used for Labrador and Big Brook.

For purposes of separating 2SW salmon from 1SW salmon in angling and other fisheries, small salmon are defined as those salmon equal to or less than 63 cm and will be mainly 1SW (grilse) in age. Large salmon are those salmon greater than 63 cm and will be mainly 2SW and older in age. These size definitions are used for biological sampling as well.

Adult salmon counts

COUNTING TECHNIQUES

Between 2 July to 8 July, 1999, a counting fence was constructed approximately 3 km upstream from the mouth of Big Brook (Fig. 2). This site was about 1 km upstream from the site used in 1997. Upstream migrating adult salmon were enumerated from 9 July to 5 September 1999; with the exception of 10 – 19 August. The counting fence consisted of 63 sections (each 3 m long) which were installed according to the description in Anderson and McDonald (1978). The fence was constructed of conduit and channel iron, supported by steel posts and 5 cm x 15 cm wooden supports similar to other portable counting fences used in Newfoundland and Labrador. The fence was operated with every conduit in place so that smaller charr and sea trout would be included in the counts.

Once the counting fence was completely installed, enumeration was done by manually releasing and counting salmon through a standard wooden fish trap. Distinction between large and small salmon was made by comparison to a known measure placed in the bottom of the fish trap. Large salmon were defined as those salmon with a fork length greater than or equal to 63 cm and small salmon are those less than 63 cm. All other fish species encountered in the trap were also enumerated.

ADJUSTED COUNTS

In 1999, the counting fence was non-operational during the period of 10 – 19 August due to a high water event during which time the conduit was removed from the fence. During this non-operational period, salmon counts were adjusted based on average counts from two days prior to and two days after the non-operational period. Also examined were the results from averaging over 4 days prior to and after the non-operational period and adjusting counts proportionately to counts in the same period in 1997.

Unrecorded Mortalities

Complete understanding of all life history factors and numbers of fish achieving each life stage including mortalities is an important part of any stock assessment (Ricker 1975). Mortalities due to fishing, but not recorded as part of the catch statistics, have been defined as non-catch fishing mortalities by Anon. (MS 1980) and Ricker (1976). Non-catch fishing mortalities could include fish killed due to illegal and legal fishing activities. In 1999, legal fishing mortalities for salmon in Labrador included catches in native food and angling fisheries. Although there were no food fishery nets set in the vicinity of Big Brook, it is possible that some Big Brook origin salmon were taken in nets near other coastal communities.

Another potential source of non-catch fishing mortality is from hook and release angling. Booth et al. (1995) and Brobbel et al (1996) have studied the effects of hook & release angling on the delayed mortality of 'bright' or returning salmon. Dempson et al. (1998) summarized all of the hook and release studies available. These studies indicated that the length of time spent in fresh water and water temperature at time of exhaustive exercise such as angling, have an effect on mortality rates. Fish that have spent longer periods of time in freshwater appear to have a lower mortality rate than those that have recently entered freshwater. Also, higher water temperatures increased the mortality rate. They concluded that mortality due to catch & release in a controlled environment was about 12%, although the sample size was small (n=25). A comparison between maximum water temperatures and numbers of salmon hooked and released for Big Brook have indicated that maximum water temperatures were low during fishing activities. Therefore, we have included an estimate of 10% mortality of caught and released fish in our calculations of total river returns and spawning escapement.

Exploitation rates

Exploitation rates for the angling fishery were determined as the number of salmon reported to have been retained by the angling fishery divided by the total number of salmon entering the river adjusted for salmon caught below the counting fence.

Biological characteristics

Biological characteristics of adult Atlantic salmon were obtained by taking samples of angling catches. These data were collected at the Big Brook (Michaels River) fishing lodge in 1997 and 1999 with the assistance of fishing guides after instruction by DFO technical staff. Information on fork length, weight, sex, and scales were collected. Samples are adequate to define the characteristics of the angling catch as most of the salmon caught in the angling fishery were sampled. Dates the samples were taken ranged from 7 July to 15 August, 1997 and 11 – 26 July, 1999.

Fecundity values used for Big Brook salmon were from Sand Hill River the only river in Labrador where fecundity has been measured. Fecundity is determined as number of eggs per kg of whole weight or number of eggs per cm fork length. The ovaries were collected from the angling fishery on Sand Hill River in 1994 and 1995 resulting in mean total egg count per small salmon of 3,808 eggs (n=96) and 5,096 eggs (n=23) per large salmon (O'Connell et al. 1997). Relative fecundity for small salmon from Sand Hill River was 1,998 eggs per kg and for large salmon 1,094 eggs per kg. In terms of fork length, relative fecundity was 68.2 eggs per cm for small salmon and 67.5 eggs per cm for large salmon. In the absence of samples from Big Brook, the Sand Hill River fecundity values were used.

Total river returns, spawning escapement, and egg deposition

TOTAL RIVER RETURNS

Total river returns (TRR) were calculated separately for small and large salmon as follows:

$$TRR = FC + RC_b + HRM_b$$

where,
FC = fish count at counting fence
RC_b = angling catch below counting fence
HRM_b = hook & release mortalities evaluated as 10% of hook & released fish the below counting fence.

SPAWNING ESCAPEMENT

Spawning escapement (SE) was calculated as the difference between the number of fish returning to the river (TRR) minus the angling catches of retained salmon above and below the fence (AC) minus 10% of hook and released salmon above the counting fence.

$$SE = TRR - (AC_a + HRM_a) - (AC_b - HRM_b)$$

where,
AC_a = angling catch above the counting fence
HRM_a = hook & release mortalities evaluated as 10% of hook & released fish above the counting fence.

EGG DEPOSITION

Egg deposition (ED) was calculated separately for small and large salmon and then summed as follows:

$$ED = SE \times PF \times RF \times FL$$

where,
SE = number of spawners
PF = proportion of females
RF = relative fecundity (No. of eggs per cm)

FL = mean fork length of female salmon

Accessible parr-rearing habitat

The entire watershed of Big Brook is accessible to migrating Atlantic salmon (Anderson 1985). Big Brook has a drainage area of 793 km^2 (Murphy 1973) which for descriptive purposes was divided into three sections by Peet (1971). The first section, from the mouth of the river to Lake Michael, includes the lower 40 km of the river. Channel widths in this section range from 25 to 50 m, and bottom substrates vary among boulder, rubble, and gravel. There are four tributaries with ideal juvenile salmon habitat entering the river in this section. The second section referred to by Peet (1971) stretches km 40 to km 53 and is made up of Lake Michael and its tributaries. None of the tributaries of Lake Michael were surveyed by Murphy (1973) and are not included in the habitat estimate. The river above Lake Michael, the third section referred to by Peet (1971), averages 18 m in width and meanders over flat, barren terrain. None of the small tributaries were surveyed in this section either; although, the main stem is included in habitat estimates (Fig. 2). From his survey in 1972, Murphy (1973) recorded a total of 22,059 rearing units on the main stem and lower tributaries (Anderson 1985). Lake Michael is 2,589 hectares but is not included in parr-rearing habitat as it is unknown if parr rear in lake habitat in SFA 1 rivers. The tributaries and ponds draining into and above Lake Michael on the main stem were also not included in the estimate of parr-rearing habitat.

Conservation Requirements

The minimum egg deposition requirement for conservation in Big Brook (SFA 1) was derived using egg deposition rates of 240 eggs per 100 m^2 for fluvial parr-rearing habitat (Elson 1957; 1975). Although these values may be habitat and river specific for river systems from which they were derived, they represent the best available data and are used as a general baseline for determining stock status of Big Brook. Biological characteristics used to calculate the conservation requirements in terms of eggs are from data collected in 1997 and 1999. Conservation requirements were converted to numbers of fish according to the method described in Reddin (1998).

Environmental data

During field operations, environmental data were collected at the fence site. Water temperatures were recorded by Hugrun thermograph set at 1 m from the surface at the fence site. Cloud cover, relative water levels, weather conditions and air temperatures were also recorded.

Analysis of risk

The accuracy of egg depositions and percent of egg conservation requirements met is very important as it describes the status of the salmon stock in Big Brook. Accuracy was investigated by a simulation exercise which investigated the variability around several key parameters and the effect of this variability on egg deposition rates. In the section on egg depositions, only the numbers of small and large salmon counted at the fence on Big Brook in 1999 were known with certainty. Total returns to the river were estimated from the fence count plus an adjustment to account for the period of non-operation of the counting fence. To account for this and some of the uncertainty in other parameter values used to determine potential egg deposition and percent of conservation requirement met, we assumed a range of values for each parameter used to

estimate egg deposition and percent of conservation requirements met. Thus, relative fecundity and fork length were set to vary at ±10%, spawning escapement was set to vary at ±20%, and proportion female at ±30%. Egg deposition and percent of conservation requirement met were calculated using 1000 realisations from a uniform distribution.

RESULTS

Angling fishery data

The DFO angling catch statistics for Labrador are largely based on data collected by angling camps. DFO data for Big Brook indicated a retained catch of 49 small salmon and 13 large salmon. Also, 41 small salmon and 9 large salmon were hooked and released (Table 1). Almost all of the fishing effort for this system comes from the fishing lodge at the mouth of the river. Some effort does occur from fishers outside the lodge who fish the upper part of Big Brook. All of the salmon angled in 1999 were assumed to have been caught below the counting fence. In 1999, the License Stub Return System (LSRS) indicated that the angling fishery in Big Brook had a retained catch of two small salmon and six large salmon. There were also 14 small salmon released. There were no large salmon released. We know that the angling camp statistics are correct as we have biological samples from the retained portion of the catch which are similar to the camp statistics. Obviously, it is the LSRS that is in error for Labrador and it is recommended that the DFO statistics be used (O'Connell et al. 1998).

Adult salmon counts

In 1997, a total of 454 small salmon and 102 large salmon adjusted for a fence washout were estimated to have returned to Big Brook (Table 2a, Fig. 3). In 1999, a total of 527 small salmon and 132 large salmon were counted upstream through the adult fence between 9 July and 5 September (Table 2b, Fig. 3). This is an underestimate of the actual number of salmon entering Big Brook due to a high water event during the period of 9 – 19 August when the fence was out of operation. Also, it is possible that a few salmon moved upstream after the fence was removed on 5 September since environmental conditions were appropriate (Fig. 4). During the high water event, conduit was removed from the fence to protect it from damage allowing salmon to move upstream unimpeded without going through the trap and without being counted. The count was adjusted for salmon moving upstream during this time by adding in the average counts of small and large salmon for two days prior to 9 August and two days after 19 August. The adjustment adds 210 small salmon and 48 large salmon to the count. If the number of days is changed to 4 days before and after then the number to be added declines to 109 small and 24 large salmon. The proportionate number entering during 9 – 19 August from 1997 can also be used to adjust the 1999 counts but on a sliding scale adjusted for differences in run timing between 1997 and 1999. The sliding scale adjusted the comparable periods between 1997 and 1999 by matching the date small salmon first entered the river in 1999 (19 July) with first small salmon in 1997 (6 July). The difference in days for small salmon is 13 days. If this technique were used then 196 small and 26 large salmon should be added. There were 50 brook trout adjusted for run timing but no charr observed at the counting fence.

Other evidence of the numbers of salmon entering during the high water period comes from field staff at Big Brook. Field staff observed around 100+ salmon downstream from the fence when the conduit was removed that were not present after the fence was back in operation and so must

have passed upstream. This would be a minimum number as more salmon could have entered the river and the chances of missing salmon in the 3 km from the fence to the sea is probably high.

In conclusion, the 737 small and 180 large salmon using adjusted counts from the 2-day within year technique were estimated to have passed through the fence in 1999 after adjustment for period when the fence was out of operation. Thus, in 1999 returns consisted of 80% small salmon and 20% large salmon. In 1997, returns to Big Brook were 530 small and 104 large salmon for 84% small and 16% large.

Also, there is some concern for the number of salmon that may have entered the river after the fence was removed on 5 September. At Sand Hill River, the average number of small salmon entering after 5 September is 2.1% and 2.8% for large. While important overall to the spawning escapement into the river, salmon entering after 5 September are low in number compared to the magnitude of returns occurring in July-August period.

In 1999, the total returns to Big Brook after adjustment for salmon angled below the counting fence and for the non-operational period was 790 small and 194 large salmon derived as follows:

Source	Small	Large	Total
Fence count	527	132	659
Adjustment	210	48	258
Angling retained	49	13	62
Angling H&R at 10%	4	1	5
Total	**790**	**194**	**984**

Exploitation rates

The DFO statistics for the catch in the angling fishery, above and below the fence, was 73 small and 2 large salmon retained and 32 small and 1 large salmon hooked and released. Exploitation rates in the angling fishery in 1997 and 1999 are as follows:

Year	Small Retained	Small Released	Large Retained	Large Released
1997 (DFO)	13.8	6.0	1.9	1.0
1999 (DFO)	6.2	5.2	6.7	4.6

In 1999, total mortality from the angling fishery on Big Brook including 10% for mortalities of hooked and released salmon was 6.7% for small salmon and 7.2% for large. Comparable numbers from 1997 were 14.3% for small and 1.9% for large. Thus, mortality rate on small salmon has doubled while that for large has declined from 1997 to 1999.

Biological Sampling

1997

In 1997, 71 adult salmon were sampled from the angling fishery. Mean fork length (FL) of the grilse was 53.8 cm (SD=2.4, n=65) and mean whole weight (WW) was 1.76 kg (SD=0.29, n=64) (Table 3a). Mean fork length of two-sea winter virgin salmon was 67.6 cm (SD=8.6, n=4) and mean WW was 3.30 kg (SD=1.29, n=4). Mean WW and FL of a single repeat spawner was 1.5 kg (n=1) and 57.8 cm (n=1), respectively.

Freshwater (river) age information is available from 67 salmon and is presented along with other biological characteristics information in Table 3a. It indicates that 87% of the adults have a river age of 5 and 6 years. The modal smolt age is 6 years.

The sea ages of the samples are 93% grilse, 6% virgin 2SW salmon and 1% repeat spawners.

The percentage of females salmon sampled from the angling fishery in 1997 was 18% (n=68) for small salmon. The large salmon were 100% female (Table 3a). The mean weight and fork length for small salmon was 1.75 kg (SD=0.292, n=67) and 54.0 (SD=2.44, n=68). For large salmon, comparable lengths and weights were 3.93 kg (SD=0.32, n=3) and 71.7 cm (SD=3.47, n=3) (Table 3a).

1999

In 1999, 54 adult salmon were sampled from the angling fishery. Mean fork length (FL) of the grilse was 56.9 cm (SD=1.58, n=35) and mean whole weight (WW) was 2.11 kg (SD=0.29, n=14) (Table 3b). Mean fork length of two-sea winter virgin salmon was 78.1 cm (SD=2.16, n=15) and mean WW was 5.08 kg (SD=0.428, n=10). There were no repeat spawners in the sample.

Freshwater (river) age information is available from 48 salmon and is presented along with other biological characteristics information in Table 3b. It indicates that 79% of the adults have a river age of 4 and 5 years. The modal smolt age is 5 years. There are not enough samples to adequately test whether the freshwater ages of small and large (or grilse and 2SW salmon) are significantly different statistically; however, in the 1999 samples small salmon are mainly 5 years while large salmon are 4 years.

The sea ages of the samples are 70% grilse and 30% virgin 2SW salmon.

The percentage of female salmon sampled from the angling fishery in 1999 was 14% (n=29) for small salmon. The large salmon were 83% (n=12) female (Table 3b). The mean weight and fork length for small salmon was 2.11 kg (SD=0.287, n=14) and 56.8 cm (SD=1.65, n=38). For large salmon, comparable lengths and weights were 5.08 kg (SD=0.428, n=10) and 77.2 cm (SD=4.32, n=16) (Table 3b).

BIOLOGICAL CHARACTERISTICS FOR ASSESSMENT

The available samples are adequate to represent the angling fishery but due to the short duration of time during which they were collected compared to returns to the river, the samples may not be representative of the population in the entire run. Also, samples that were sexed are too low in

number to adequately define sex ratios. The sex ratio in particular for small salmon is extremely low compared to other rivers in Labrador and in part may have been due to the distribution of samples over the run. Samples were taken from angled (only retained salmon) and thus come from only when the angling fishery was operational rather than being obtained over the entire run. Consequently, a proportion of 0.5 female for small salmon and 0.8 for large salmon was used in the assessment similar to Sand Hill River (Reddin et al. 1995) which also has a MSW salmon component (Table 4a).

Analysis of variance was used to compare mean fork lengths of salmon captured by angling and sampled in 1997 and 1999. Overall model had an R^2 of 0.89. Year effects were significant at less than 5% ($F_{1,110}$=33.23, P=0.0001) as were size effects ($F_{1,110}$=384.2, P=0.0001) while fork lengths of males and females were not significantly different from each other ($F_{1,110}$=3.02, P=0.09). This suggests that the assessment should be done with separate values for 1997 vs 1999 and for large vs small salmon but that samples from male and female salmon could be combined.

The combined 1997 and 1999 river age distribution of returning adult salmon of both sizes is dominated by 5- and 6-year olds (Table 4b). In 1997, there were more 6-year olds on a proportionate basis while in 1999, 5-year olds dominated in small salmon. In 1999, small salmon were predominately 5-year old while large salmon were 4-year old. Small sample sizes precluded being definitive about the samples.

Parameter values of small and large salmon used for the determination of egg deposition include mean fork lengths, proportion female. In 1997, the best estimate of mean fork length of small salmon (male and female included) is 54.0 cm for small salmon and 71.7 cm for large salmon (Table 4a). Comparable values for 1999 are 56.8 cm for small and 77.2 cm for large salmon. In both 1997 and 1999, the percent female is very low at 17.6% in 1997 and 13.8% in 1999 for small salmon. For large salmon, it was 100% in 1997 due to the low sample size of 2 fish and 83.3% in 1999. Combined 1997 and 1999 samples gave 85.7%. The proportion female for small and large salmon used in the estimation of egg deposition was 0.5 and 0.8, respectively (Table 5).

Accessible parr-rearing habitat

The estimate of 22,059 parr-rearing units for Big Brook is a minimum value as only the rearing areas of tributaries in the lower section of the river were included and pond area was not considered (Murphy 1973). Another source of error is that all linear distances were measured using 1:250,000 scale maps and were measured by hand-held planimeter. Comparison of habitat measured on 1:50,000 scale maps versus the 1:250,000 scale maps indicates that some habitat will be overlooked.

Conservation requirements

The estimated conservation requirements in eggs for Big Brook are as follows:

Fluvial Rearing Units:	22,059 (100 m^2)
Lacustrine Rearing Area:	Not included

Standard Conservation Egg Deposition Requirements: Fluvial = 240 eggs per rearing unit

Egg Deposition Required for Conservation:

= Conservation egg requirements * Accessible parr rearing area

= 240 * 22,059

= 5,294,160 eggs

Conservation requirements in numbers of salmon:

$$\frac{5{,}294{,}160}{(0.804 * (0.5 * 68.2 * 56.8)) + (0.196 * (0.8 * 67.5 * 76.3))}$$

= 2,239 salmon (1,780 small and 439 large salmon)

Total river returns, spawning escapement, and egg deposition

In 1999, the total river returns to Big Brook were estimated at 737 small and 180 large salmon after correction for a non-operational period during 10-19 August inclusive and for mortalities in the angling fishery below the fence (Table 5). The retained angling catch below the counting fence in 1999 was 49 small and 13 large salmon. Therefore, spawning escapement was 684 small and 166 large salmon corrected for angling and hook and release mortalities.

In 1999, egg deposition was estimated at 2,017,070 eggs which was 38% of the conservation requirements (Table 5). This estimate has several possible sources of error. First, although adjusted for, there was a ten-day period of non-operation of the counting fence. Second, although probably low in number there were potentially returns of salmon to the river after fence removal. Third, sample sizes used to derive biological characteristics are low, especially for sex ratios. Samples are adequate to define characteristics of the catch but were not taken over the entire run. Fourth, is the use of 1;250,000 scale charts for habitat measurements and non-inclusion of some tributary streams which to some degree will under-estimate habitat.

Analysis of risk

In determining egg deposition in the previous section, only the numbers of small and large salmon counted at the fence on Big Brook in 1999 were known with certainty. If specific levels of variability are assumed for each of these parameters and 1000 realizations made assuming a uniform distribution and egg deposition and percent of conservation requirements met calculated at each realization, then Big Brook still would not achieve 100% of conservation requirements (Fig. 5). At the 50th percentile, 1,979,695 eggs were deposited which represents 37% of conservation requirement of 5,294,160 eggs based on this level of variation (Fig. 5). The corresponding 5th and 95th percentiles of the percentage of conservation requirement met varied from 27 to 51% (Fig. 6).

Environmental data

Fig. 7 shows the daily mean water temperatures at the fence on Big Brook. Also shown are the maximum and minimum water temperatures from the fence site compared to the number of hooked and released small and large salmon for the river system in 1997 and 1999. It would

appear from the relatively cool water and low overall number of hooked and released salmon that mortalities are low compared to the population size.

DISCUSSION

In 1999, 737 small and 180 large salmon were estimated to have returned to Big Brook, Labrador. This is an increase of 39% and 73% over the 530 small and 104 large salmon that returned in 1997. The conservation requirement of 5,294,160 eggs is the first established for a northern Labrador river continuing a process that began in 1990 (O'Connell and Dempson 1991). The calculated percentage of 38% of the conservation requirement achieved is very low; although up considerably from the 24% in 1997. It is possible that in spite of adjusting the total returns for salmon entering during the non-operation of the counting fence that more salmon entered than were accounted for. If so, then the spawning escapement and percent of conservation requirement achieved would be an underestimate. However, given the low numbers of salmon entering otherwise would suggest that even if the actual number was underestimated, the percent conservation requirement achieved is still low as shown by the risk analysis. Because of the low returns in 1999 and the uncertainty in the estimates, it is recommended that the assessment be repeated in 2000. Also assessments should be conducted on other northern Labrador rivers. Some consideration should be given to verifying and if necessary refining the conservation requirements of 240 eggs per 100 m^2 for Labrador rivers. The standard conservation requirement for Atlantic Coast salmon was derived from rivers in the southern range of salmon distribution (Chaput MS 1997) and may be different for rivers in Labrador; especially where charr and sea trout are also present.

Murphy (1973) considers that Big Brook is capable of producing circa. 6600 salmon annually. Some of these salmon would have been taken in the commercial fishery. Although in recent years as a result of reductions in commercial fishing effort and closure in 1998, a higher proportion of the total population would be found in freshwater. Another way of examining stock status for Big Brook is to compare the numbers of salmon returning to the river versus those at Sand Hill River. When adjusted for the difference in drainage area (Big Brook - 793 km^2, Sand Hill – 1,276 km^2) gives 1,718 small and 353 large salmon for Big Brook if it were at the same average level of production as Sand Hill River was in 1994-96. The actual returns to Big Brook of 737 small and 180 large are 43% and 51% of the adjusted Sand Hill River returns. Ranger seals (*Phoca vitulina)* are known to overwinter and breed in the lower 10 km of this river and are likely predators on fish populations. It is possible that predation by seals and exploitation by man have reduced spawners to this level of production. In addition, salmon populations are known for their high degree of annual variability and it may be that the salmon returns to Big Brook in 1999 were low due to this variability while other years were higher.

Complete knowledge of exploitation patterns of fish stocks is important information for stock assessments. Because of a lack of assessments on northern and southern Labrador rivers, this information is generally lacking. For Big Brook in 1999, exploitation rates for the angling fishery were 6.2% on small retained salmon, 5.2% on small released salmon, 6.7% on large retained salmon and 4.6% on large released salmon. Exploitation rates are also available for Sand Hill River in southern Labrador (Reddin et al. 1995). In the early 1970s, average exploitation rates were 6% on small salmon and 2% on large salmon. In the 1990s, exploitation had increased to 11% on retained small salmon and 4% on retained large salmon. For released

salmon, exploitation rates were 14% on small salmon and 4% on large salmon. These level of removals decrease the percentage of conservation requirements met by 3%.

O'Connell and Dempson (MS 1991) reported that there is evidence (unpublished) that atresia (the non-development and reabsorption of eggs) occurs to varying degrees in insular Newfoundland salmon. This phenomenon has also been reported in Atlantic salmon in the Soviet Union (Melnikova 1964) and in France (Prouzet *et al.* 1984). Therefore, fecundity values measured from eggs in early stages of development (green eggs) should be regarded as potential values. Since calculations of conservation requirements and the percent of conservation requirements achieved were based on green eggs, the occurrence of atresia in a given year on a particular river would increase the number of spawners required and decrease the percent of the requirements achieved. Also, fecundity values used to determine egg deposition in Big Brook were derived from Sand Hill River salmon.

In conclusion, this paper summarizes the stock status of the salmon population in Big Brook, Labrador. Although, there were several questions to be resolved it would appear that returns to Big Brook and the number of spawners were low in 1999; although they increased over 1997 values. Assessments of rivers in SFA 1 and should be continued to obtain assessment information for northern Labrador rivers in future years.

ACKNOWLEDGEMENTS

The assistance of the staff of Atlantic Sports Fishing Inc. is gratefully acknowledged. Mr. W. Bennett, operator of Atlantic Sports Fishing Inc., proposed and sponsored the stock assessment study on Big Brook (Michaels River). Much of this was done using his funds for which he has not been compensated. The staff at Michaels River lodge and in particular Mr. J. Small and D. Coley who looked after the counting fence records are acknowledged.

REFERENCES

Anon. MS 1980. Report of the Working Group on North Atlantic Salmon. ICES C.M. 1980/M:10, 52 p.

Anderson, T. C. 1985. The Rivers of Labrador. Can. Spec. Publ. Fish. Aquat. Sci. 81: 389p.

Anderson, T. C. and B. P. McDonald. 1978. A portable weir for counting migrating fishes in rivers. Fish. Mar. Serv. Tech. Rep. 733: 13 p.

Ash, E. G. M., and M. F. O'Connell. 1987. Atlantic salmon fishery in Newfoundland and Labrador, commercial and recreational, 1985. Can. Data Rep. Fish. Aquat. Sci. 672: v + 284 p.

Booth, R. K., J. D. Kieffer, K. Davidson, A. Bielak, and B. L. Tufts. 1995. Effects of late-season catch and release angling on anaerobic metabolism, acid-base status, survival and gamete viability in wild Atlantic salmon (*Salmo salar*). Can. J. Fish. Aquat. Sci. 52: 283-290.

Brobbel, M. A., M. P. Wilkie, K. Davidson, J. D. Kieffer, A. T. Bielak, and B. L. Tufts. 1996. Physiological effects of catch and release angling in Atlantic salmon (*Salmo salar*) at different stages of freshwater migration. Can. J. Fish. Aquat. Sci. 53: 2036-2043.

Chaput, G. J. [ed.] 1997. Proceedings of a workshop to review conservation principles for Atlantic salmon in Eastern Canada. Canadian Stock Assessment Proceedings Series 97/15, 33 p.

Dempson, J. B., D. G. Reddin, and M. F. O'Connell. 1998. To what extent does catch and release contribute to mortality in Atlantic salmon? DFO Atlantic Fisheries Research Document 98/99, 14 p.

Elson, P. F. 1957. Using hatchery reared Atlantic salmon to best advantage. Can. Fish. Cult. 21: 7-17.

Elson, P. F. 1975. Atlantic salmon rivers, smolt production and optimal spawning: an overview of natural production. Int. Atl. Salmon Found. Spec. Publ. Ser. 6: 96-119.

Melnikova, M. N. 1964. The fecundity of Atlantic salmon (*Salmo salar* L.) from the Varguza River. Vopr. Ikhtiol. 4: 469-476.

Murphy, H. P. 1973. A helicopter reconnaissance survey of 17 Labrador rivers, August, 1972. Fish. Serv. Res. Dev. Branch Nfld. Reg. Prog. Rep. 101:xi+177 p.

O'Connell, M. F. and J. B. Dempson. MS 1991. Atlantic salmon (*Salmo salar* L.) target spawning requirements for rivers in Notre Dame Bay (SFA 4), St. Mary's Bay (SFA 9), and Placentia Bay (SFA 10), Newfoundland. CAFSAC Res. Doc. 91/18, 14 p.

O'Connell, M. F., J. B. Dempson, and D. G. Reddin. 1997. Inter-annual and inter-river variability in fecundity in Atlantic salmon (Salmo salar L.) in Newfoundland rivers. DFO, CSAS Res. Doc. 97/94, 33 p.

O'Connell, M. F. N. M. Cochrane, E. G. M. Ash, and C. C. Mullins. MS 1998. An analysis of the License Stub Return System in the Newfoundland Region, 1994-97. DFO, CSAS Res. Doc. 98/111, 67 p.

Peet, R. F. 1971. A report on the counting trap and reconnaissance surveys conducted in central coastal Labrador during 1967. Resource Development Branch, Internal Report Series Progress Report No. 68. 283p.

Pratt, J. D., G. M. Hare, and G. M. Murphy. 1974. Investigations of production and harvest of an Atlantic salmon population, Sand Hill River, Labrador. Fish. Mar. Serv. Res. Dev. Branch Tech. Rep. Ser. No. NEW/T-74-1: iii+ 27p.

Prouzet, P., Y. LeBail, and M. Heydorff. 1984. Sex ratio and potential fecundity of Atlantic salmon (*Salmo salar* L.) caught by anglers on the Elorn River (Northern Brittany, France) during 1979 and 1980. Fish. Mgmt. 15: 123-130.

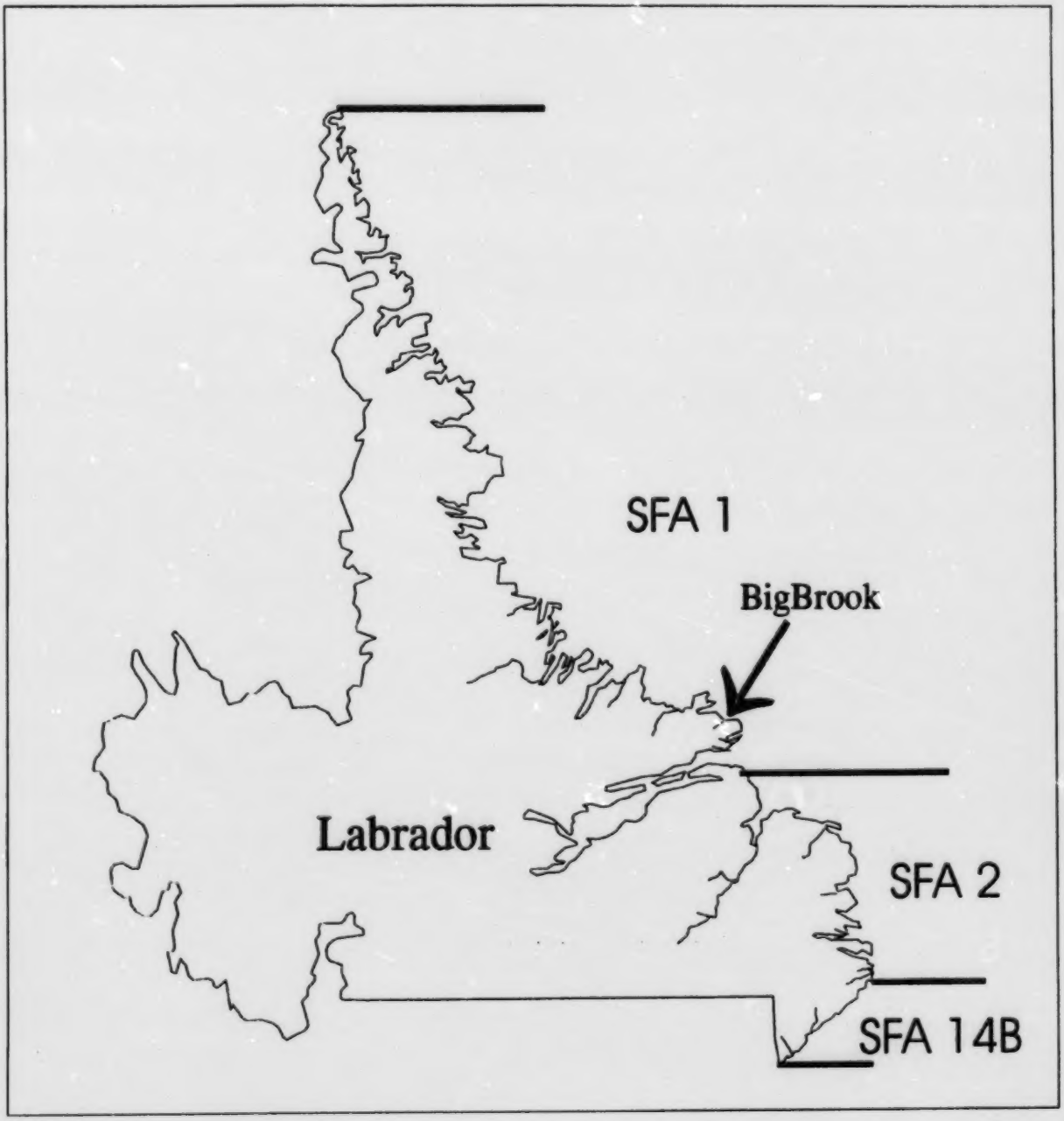
Reddin, D.G., P.B. Short, M.F. O'Connell and A.D. Walsh. 1995. Assessment of the Atlantic salmon population Sand Hill River, Labrador, 1994. DFO Atlantic Fisheries Res. Doc. 95/97. 30 p.

Reddin, D. G. 1998. Proceedings of the 1997 Newfoundland Region Salmonid Stock Assessment Meeting. CSAS Proceedings Series 98/01, 78 p.

Ricker, W. E. 1975. Computation and interpretation of biological statistics of fish populations. Fish. Marine Serv. Bull. 191, 382 p.

Ricker, W. E. 1976. Review of the rate of growth and mortality of Pacific salmon in salt water and non-catch mortality caused by fishing. J. Fish. Res. Bd Canada 33: 1483-1524.

Fig. 1. Location map depicting Labrador, Salmon Fishing Areas (SFAs) and Big Brook.



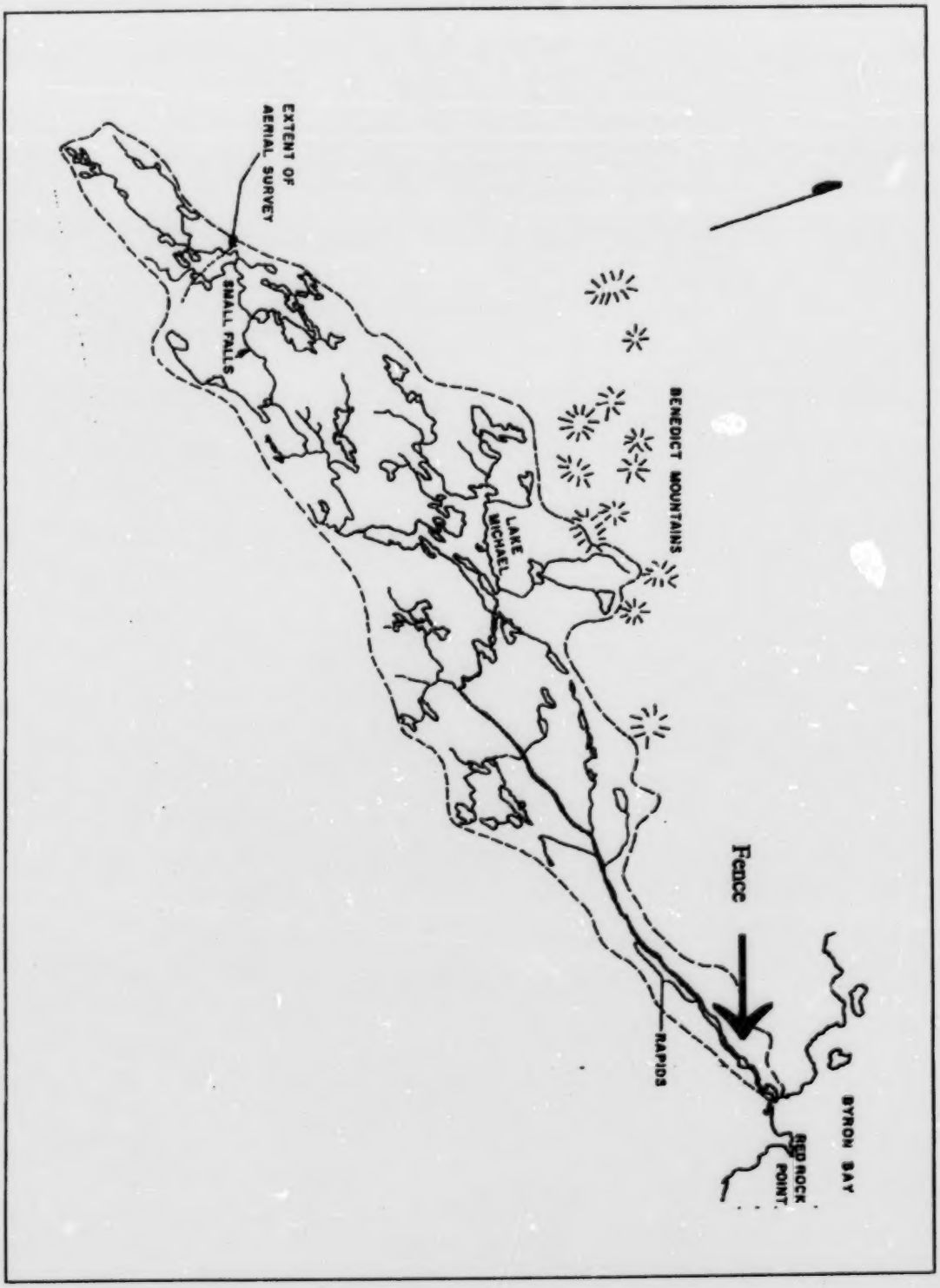


Fig. 2. Drainage basin for Big Brook, Labrador and location of fence site.

Fig. 3. Numbers and cumulative percent of small and large salmon entering Big Brook in 1997 & 1999.

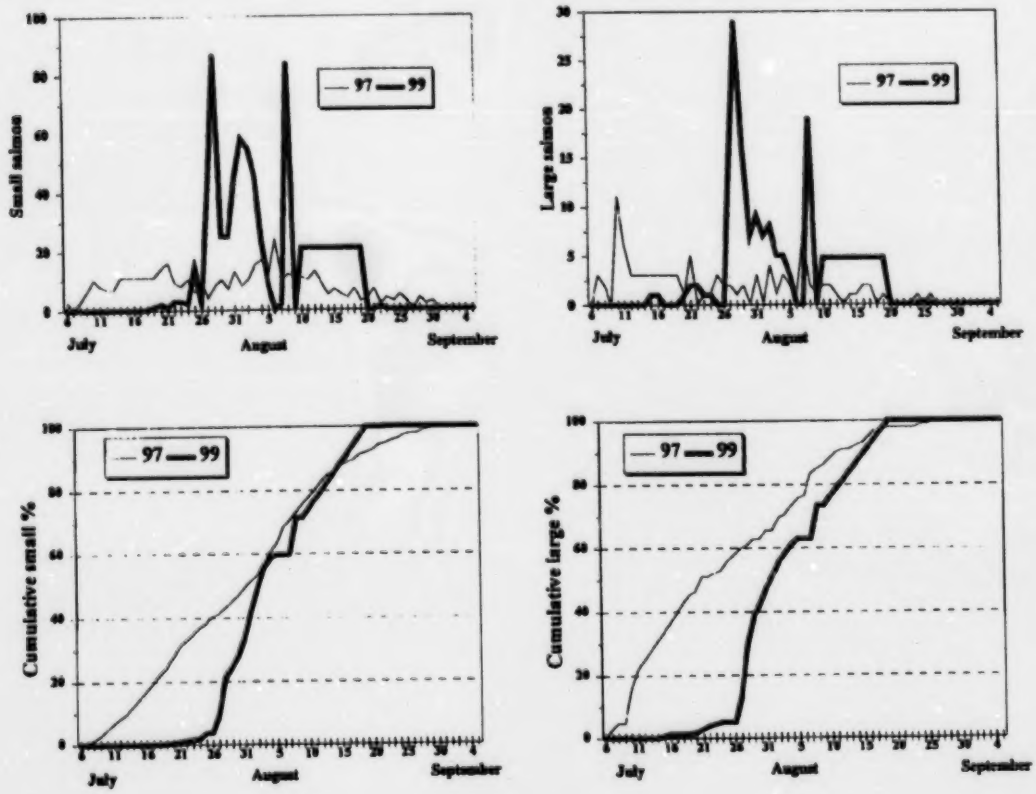


Fig. 4. Water levels at the counting trap, Big Brook in 1997 & 1999.

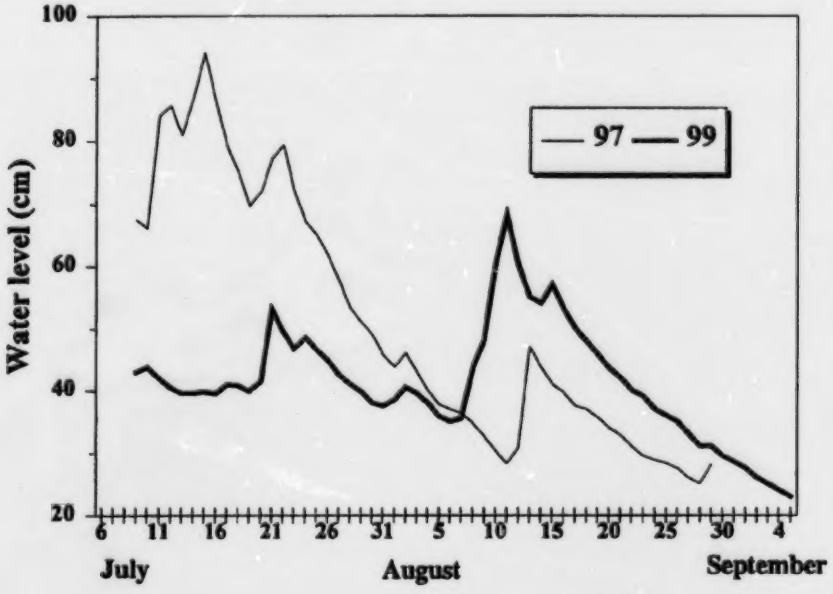
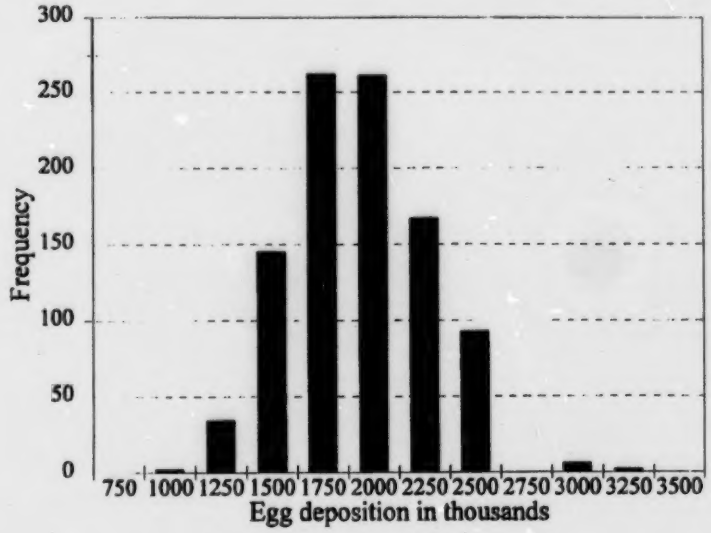


Fig. 5. Frequency distribution of the estimated egg deposition at Big Brook, 1999 (upper panel) and the corresponding probability distribution (lower panel). The analysis with 1000 realizations assumed a 20% coefficient of variation around proportion female, relative fecundity, and mean weight of the small and large salmon components. Egg depositions are at the mid-point of each interval.



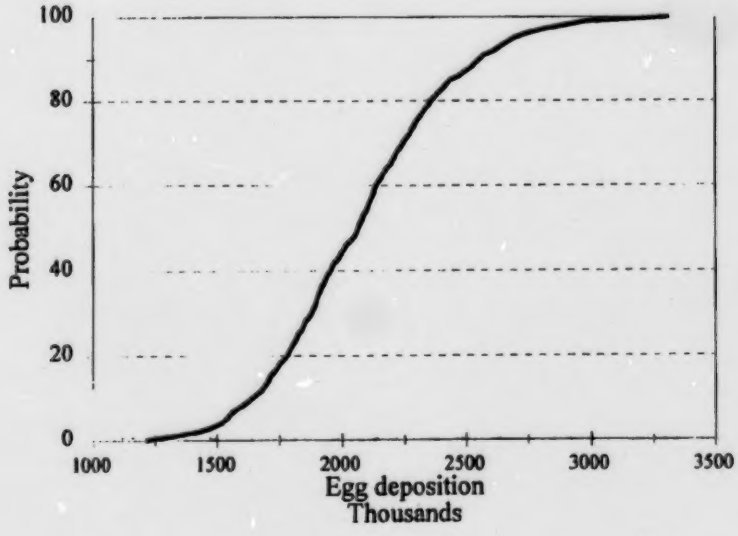
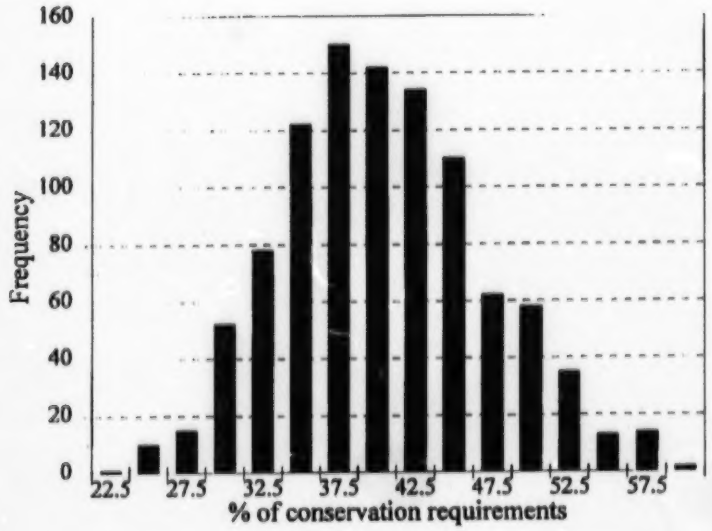


Fig. 6. Frequency distribution of the estimated percent of conservation requirement met at Big Brook, 1999 (upper panel) and the corresponding probability distribution (lower panel). The analysis with 1000 realizations assumed a 20% coefficient of variation around proportion female, relative fecundity, and mean weight of the small and large salmon components. Percent met are at the mid-point of each interval.



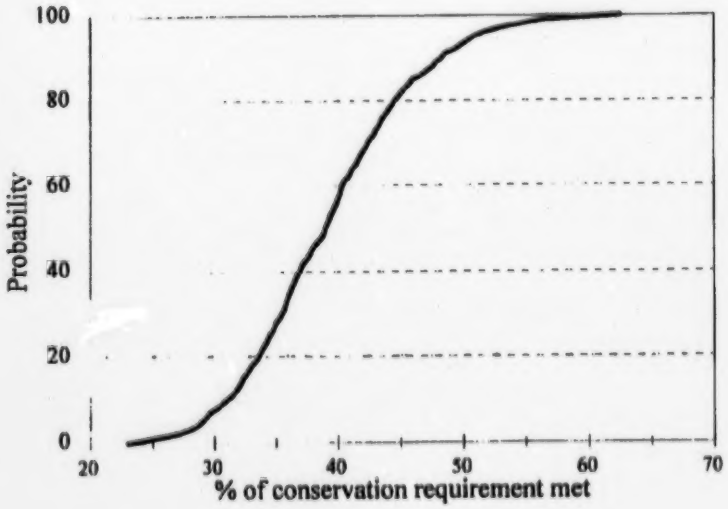


Fig. 7. Water temperatures and number of hooked and released salmon, Big Brook in 1997 (upper panel) & 1999 (lower panel).

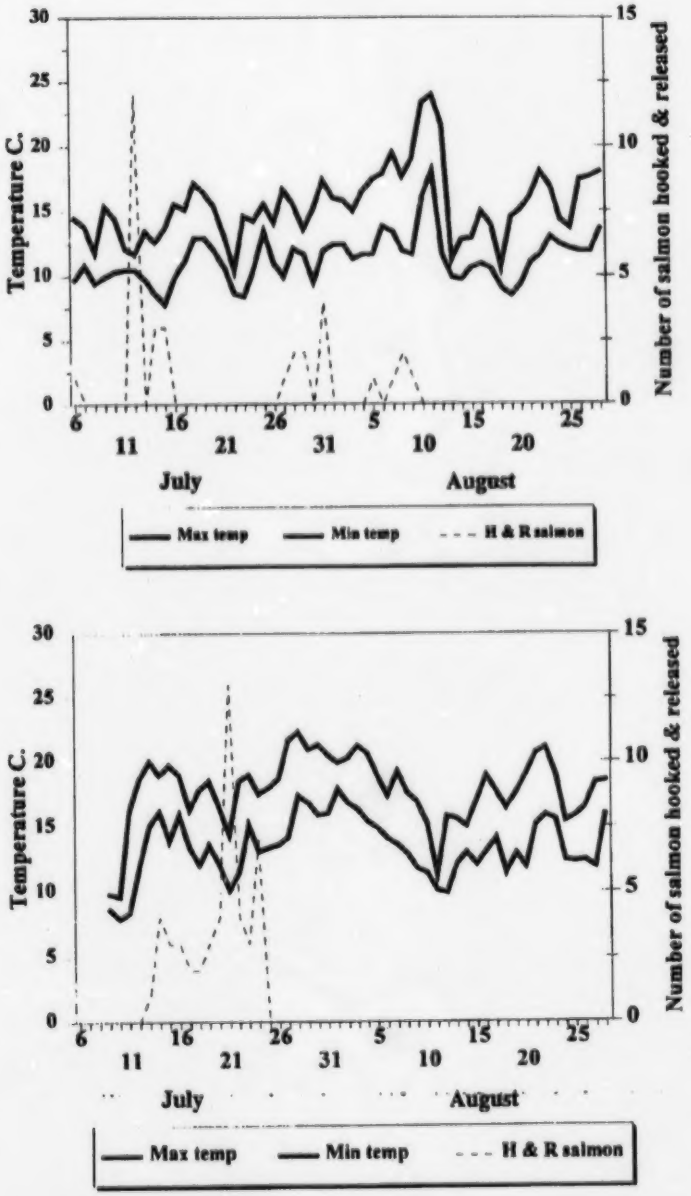


Table 1. DFO angling catch statistics for Big Brook, Labrador, 1974-99.

Code: 5714280

	Effort	Small (<63 cm)			Large (>=63 cm)			Total (Small + Large)				Proportion
Year	Rod Days	Ret.	Rel.	Tot.	Ret.	Rel.	Tot.	Ret.	Rel.	Tot.	CPUE	Large
1974	332	246	.	246	43	.	43	289	.	289	0.87	0.15
1975	.	.	.	.	.	.	.	.	.	.	.	.
1976	.	.	.	.	.	.	.	.	.	.	.	.
1977	.	.	.	.	.	.	.	.	.	.	.	.
1978	.	.	.	.	.	.	.	.	.	.	.	.
1979	266	310	.	310	107	.	107	417	.	417	1.57	0.26
1980	69	27	.	27	1	.	1	28	.	28	0.41	0.04
1981	.	.	.	.	.	.	.	.	.	.	.	.
1982	89	50	.	50	16	.	16	66	.	66	0.74	0.24
1983	69	20	.	20	1	.	1	21	.	21	0.30	0.05
1984	242	21	.	21	10	.	10	31	.	31	0.13	0.32
1985	.	.	.	.	.	.	.	.	.	.	.	.
1986	173	52	.	52	4	.	4	56	.	56	0.32	0.07
1987	56	37	.	37	6	.	6	43	.	43	0.77	0.14
1988	221	363	.	363	35	.	35	398	.	398	1.80	0.09
1989	298	412	.	412	46	.	46	458	.	458	1.54	0.10
1990	217	251	.	251	20	.	20	271	.	271	1.25	0.07
1991	455	79	.	79	7	.	7	86	.	86	0.19	0.08
1992	298	33	0	33	172	0	172	205	0	205	0.69	0.84
1993	.	.	.	.	.	.	.	.	.	.	.	.
1994	242	62	22	84	10	1	11	72	23	95	0.39	0.12
1995	152	92	21	113	5	0	5	97	21	118	0.78	0.04
1996	183	36	12	48	5	0	5	41	12	53	0.29	0.09
1997	427	73	32	105	2	1	3	75	33	108	0.25	0.03
1998	191	54	24	78	4	2	6	58	26	84	0.44	0.07
1999**	92	49	41	90	13	9	22	62	50	112	1.22	0.20
84-89 X	198.0	177.0	.	177.0	20.2	.	20.2	197.2	.	197.2	0.9	0.1
95% CL	113.2	239.9	.	239.9	23.7	.	23.7	263.1	.	263.1	0.9	0.1
N	5	5	0	5	5	0	5	5	0	5	5	5
86-91 $\bar{X}$	236.7	199.0	.	199.0	19.7	.	19.7	218.7	.	218.7	0.6	0.2
95% CL	139.8	173.9	.	173.9	18.3	.	18.3	191.9	.	191.9	0.7	0.4
N	6	6	0	6	6	0	6	6	0	6	6	6
92-96 $\bar{X}$	218.8	55.8	13.8	69.5	48.0	0.3	48.3	103.8	14.0	117.8	0.5	0.3
95% CL	160.7	68.2	25.4	89.5	205.5	1.2	205.1	177.1	26.1	159.2	0.6	0.9
N	3	3	3	3	3	3	3	3	3	3	3	3

IN THE ABOVE TABLE A PERIOD INDICATES NO DATA FOR THAT YEAR.
CPUE IS BASED ON RETAINED + RELEASED FISH FOR 1992 - 1998 AND ON RETAINED FISH ONLY PRIOR TO 1992.
**PRELIMINARY

Table 2a. Daily counts of upstream migrating Atlantic salmon at Big Brook (Michaels River),Labrador in 1997. Fence was non-functional from 2100 hours on July 14 to 1300 hours on July 19. Numbers in bold italics are estimates. On July 14, 4 small and 3 large salmon were counted and on 19 July 2 small and 0 large were counted during the period of the day the counting fence was operational.

	Number of fish		Cumulative number			Cumulative percentages			% large
DATE	SMALL	LARGE	SMALL	LARGE	TOTAL	SMALL	LARGE	TOTAL	salmon
6 July	3	0	3	0	3	1	0	1	0
7 July	0	3	3	3	6	1	3	1	100
8 July	3	2	6	5	11	1	5	2	40
9 July	6	0	12	5	17	3	5	3	0
10 July	10	11	22	16	38	5	16	7	52
11 July	8	6	30	22	52	7	22	9	43
12 July	7	3	37	25	62	8	25	11	30
13 July	7	3	44	28	72	10	27	13	30
14 July	*11*	*3*	55	31	86	12	30	15	21
15 July	*11*	*3*	66	34	100	15	33	18	21
16 July	*11*	*3*	77	37	114	17	36	21	21
17 July	*11*	*3*	88	40	128	19	39	23	21
18 July	*11*	*3*	99	43	142	22	42	26	21
19 July	*11*	*3*	110	46	156	24	45	28	21
20 July	14	1	124	47	171	27	46	31	7
21 July	16	5	140	52	192	31	51	35	24
22 July	9	0	149	52	201	33	51	36	0
23 July	8	1	157	53	210	35	52	38	11
24 July	10	1	167	54	221	37	53	40	9
25 July	6	3	173	57	230	38	56	41	33
26 July	10	2	183	59	242	40	58	44	17
27 July	4	2	187	61	248	41	60	45	33
28 July	8	1	195	62	257	43	61	46	11
29 July	10	2	205	64	269	45	63	48	17
30 July	7	0	212	64	276	47	63	50	0
31 July	13	3	225	67	292	50	66	53	19
1 August	8	0	233	67	300	51	66	54	0
2 August	10	4	243	71	314	54	70	56	29
3 August	15	1	258	72	330	57	71	59	6
4 August	17	3	275	75	350	61	74	63	15
5 August	11	2	286	77	363	63	75	65	15
6 August	24	1	310	78	388	68	76	70	4
7 August	10	7	320	85	405	70	83	73	41
8 August	12	2	332	87	419	73	85	75	14
9 August	11	1	343	88	431	76	86	78	8
10 August	11	2	354	90	444	78	88	80	15
11 August	10	2	364	92	456	80	90	82	17
12 August	13	1	377	93	470	83	91	85	7
13 August	9	0	386	93	479	85	91	86	0
14 August	5	1	391	94	485	86	92	87	17
15 August	7	1	398	95	493	88	93	89	13
16 August	5	2	403	97	500	89	95	90	29
17 August	4	2	407	99	506	90	97	91	33
18 August	7	0	414	99	513	91	97	92	0
19 August	3	1	417	100	517	92	98	93	25
20 August	4	0	421	100	521	93	98	94	0
21 August	7	0	428	100	528	94	98	95	0
22 August	2	0	430	100	530	95	98	95	0
23 August	4	0	434	100	534	96	98	96	0
24 August	3	1	437	101	538	96	99	97	25
25 August	5	0	442	101	543	97	99	98	0
26 August	3	1	445	102	547	98	100	98	25
27 August	0	0	445	102	547	98	100	98	0
28 August	4	0	449	102	551	99	100	99	0
29 August	2	0	451	102	553	99	100	99	0
30 August	3	0	454	102	556	100	100	100	0
31 August	0	0	454	102	556	100	100	100	0
1 Sept	0	0	454	102	556	100	100	100	0
2 Sept	0	0	454	102	556	100	100	100	0
3 Sept	0	0	454	102	556	100	100	100	0
4 Sept	0	0	454	102	556	100	100	100	0
5 Sept	0	0	454	102	556	100	100	100	0
Totals	454	102							18
Total without 14-19 July	388	84							

Table 2b. Daily counts of upstream migrating Atlantic salmon at Big Brook (Michaels River),Labrador in 1999. Fence in operation from July 9, 1999 to 1000 hours Sept 5, 1999 except for a period between 0600 hours on August 10 to 1700 hours on August 19, 1999. Numbers in bold italics are estimates. On July 14, 4 small and 3 large salmon were counted and on 19 July, 2 small and 0 large were counted during the period of the day the counting fence was operational.

	Number of fish		Cumulative numbers			Cumulative percentages			% large
DATE	SMALL	LARGE	SMALL	LARGE	TOTAL	SMALL	LARGE	TOTAL	salmon
6 July	0	0	0	0	0	0.0	0.0	0.0	0
7 July	0	0	0	0	0	0.0	0.0	0.0	0
8 July	0	0	0	0	0	0.0	0.0	0.0	0
9 July	0	0	0	0	0	0.0	0.0	0.0	0
10 July	0	0	0	0	0	0.0	0.0	0.0	0
11 July	0	0	0	0	0	0.0	0.0	0.0	0
12 July	0	0	0	0	0	0.0	0.0	0.0	0
13 July	0	0	0	0	0	0.0	0.0	0.0	0
14 July	0	0	0	0	0	0.0	0.0	0.0	0
15 July	0	1	0	1	1	0.0	0.6	0.1	100
16 July	0	1	0	2	2	0.0	1.1	0.2	100
17 July	0	0	0	2	2	0.0	1.1	0.2	0
18 July	0	0	0	2	2	0.0	1.1	0.2	0
19 July	1	0	1	2	3	0.1	1.1	0.3	0
20 July	2	1	3	3	6	0.4	1.7	0.7	33
21 July	1	2	4	5	9	0.5	2.8	1.0	67
22 July	3	2	7	7	14	0.9	3.9	1.5	40
23 July	3	1	10	8	18	1.4	4.5	2.0	25
24 July	2	1	12	9	21	1.6	5.0	2.3	33
25 July	14	0	26	9	35	3.5	5.0	3.8	0
26 July	2	0	28	9	37	3.8	5.0	4.0	0
27 July	40	15	68	24	92	9.2	13.4	10.0	27
28 July	87	29	155	53	208	21.0	29.5	22.7	25
29 July	25	16	180	69	249	24.4	38.4	27.2	39
30 July	25	7	205	76	281	27.8	42.3	30.7	22
31 July	45	9	250	85	335	33.9	47.4	36.6	17
1 August	58	7	308	92	400	41.8	51.3	43.6	11
2 August	55	8	363	100	463	49.3	55.7	50.5	13
3 August	46	5	409	105	514	55.5	58.5	56.1	10
4 August	23	5	432	110	542	58.6	61.3	59.1	18
5 August	8	3	440	113	553	59.7	63.0	60.3	27
6 August	0	0	440	113	553	59.7	63.0	60.3	0
7 August	2	0	442	113	555	60.0	63.0	60.6	0
8 August	84	19	526	132	658	71.4	73.5	71.8	18
9 August	0	0	526	132	658	71.4	73.5	71.8	0
10 August	*21*	*5*	547	137	684	74.2	76.2	74.6	18
11 August	*21*	*5*	568	142	710	77.1	78.8	77.4	18
12 August	*21*	*5*	589	146	735	79.9	81.5	80.2	18
13 August	*21*	*5*	610	151	761	82.8	84.1	83.0	18
14 August	*21*	*5*	631	156	787	85.6	86.8	85.8	18
15 August	*21*	*5*	652	161	813	88.5	89.4	88.7	18
16 August	*21*	*5*	673	165	838	91.3	92.1	91.5	18
17 August	*21*	*5*	694	170	864	94.2	94.7	94.3	18
18 August	*21*	*5*	715	175	890	97.0	97.4	97.1	18
19 August	*21*	*5*	736	180	916	99.9	100.0	99.9	18
20 August	0	0	736	180	916	99.9	100.0	99.9	0
21 August	0	0	736	180	916	99.9	100.0	99.9	0
22 August	1	0	737	180	917	100.0	100.0	100.0	0
23 August	0	0	737	180	917	100.0	100.0	100.0	0
24 August	0	0	737	180	917	100.0	100.0	100.0	0
25 August	0	0	737	180	917	100.0	100.0	100.0	0
26 August	0	0	737	180	917	100.0	100.0	100.0	0
27 August	0	0	737	180	917	100.0	100.0	100.0	0
28 August	0	0	737	180	917	100.0	100.0	100.0	0
29 August	0	0	737	180	917	100.0	100.0	100.0	0
30 August	0	0	737	180	917	100.0	100.0	100.0	0
31 August	0	0	737	180	917	100.0	100.0	100.0	0
1 Sept	0	0	737	180	917	100.0	100.0	100.0	0
2 Sept	0	0	737	180	917	100.0	100.0	100.0	0
3 Sept	0	0	737	180	917	100.0	100.0	100.0	0
4 Sept	0	0	737	180	917	100.0	100.0	100.0	0
5 Sept	0	0	737	180	917	100.0	100.0	100.0	0
Total	737	180							20
Total without Aug10-19	527	132							

Table 3a. Biological characteristic data for Big Brook (Michaels River), Labrador, 1997.

Class	Type	Fork length (cm)	Whole weight (kg)	Female Percent	Female Number		River age distribution 1	2	3	4	5	6	7	Total
Small salmon	Mean	54.0	1.75	18	12(68)	Number	0	0	2	7	21	34	0	64
	SD	2.44	0.292			Percent	0	0	3	11	33	53	0	100
	N	68	67											
Large salmon	Mean	71.7	3.93	100	2(2)	Number	0	0	0	0	3	0	0	3
	SD	3.47	0.322			Percent	0	0	0	0	100	0	0	100
	N	3	3											
Grilse	Mean	53.8	1.76	15	10(65)	Number	0	0	2	6	21	33	0	62
	SD	2.40	0.293			Percent	0	0	3	10	34	53	0	100
	N	65	64											
2SW	Mean	67.6	3.30	100	3(3)	Number	0	0	0	0	3	1	0	4
	SD	8.63	1.29			Percent	0	0	0	0	75	25	0	100
	N	4	4											
Repeat spawners	Mean	57.8	1.5	100	1(1)	Number	0	0	0	1	0	0	0	1
	SD	NA	NA			Percent	0	0	0	100	0	0	0	100
	N	1	1											
All salmon	Mean	54.7	1.84	20	14(70)	Number	0	0	2	7	24	34	0	67
	SD	4.35	0.532			Percent	0	0	3	10	36	51	0	100
	N	71	70											

Table 3b. Biological characteristic data for Big Brook (Michaels River), Labrador, 1999.

Class	Type	Fork length (cm)	Whole weight (kg)	Female		River age distribution								
				Percent	Number		1	2	3	4	5	6	7	Total
Small salmon	Mean	56.8	2.11	14	4(29)	Number	0	0	0	3	30	0	1	34
	SD	1.65	0.287			Percent	0	0	0	9	88	0	3	100
	N	38	14											
Large salmon	Mean	77.2	5.08	83	10(12)	Number	0	0	0	6	5	3	0	14
	SD	4.32	0.428			Percent	0	0	0	43	36	21	0	100
	N	16	10											
Grilse	Mean	56.9	2.11	15	4(26)	Number	0	0	0	3	30	0	1	34
	SD	1.58	0.287			Percent	0	0	0	9	88	0	3	100
	N	35	14											
2SW	Mean	78.1	5.08	91	10(11)	Number	0	0	0	6	5	3	0	14
	SD	2.16	0.428			Percent	0	0	0	43	36	21	0	100
	N	15	10											
Repeat spawners	Mean	NA	NA	0	0	Number	0	0	0	0	0	0	0	0
	SD	NA	NA			Percent								
	N	0	0											
All salmon	Mean	62.9	3.34	34	14(41)	Number	0	0	0	9	35	3	1	48
	SD	9.75	1.53			Percent	0	0	0	19	73	6	2	100
	N	54	24											

Table 4a. Biological characteristics of male and female salmon used for the assessment.

Class	Year	Type	Fork length (cm)	Whole weight (kg)	Percent female[1]
Small	1997	Mean	54.0	1.75	17.7
		SD	2.440	0.292	
		N	68	67	68
	1999	Mean	56.8	2.11	13.8
		SD	1.650	0.287	
		N	38	14	29
	Both years	Mean	55.0	1.81	16.5
		SD	2.586	0.320	
		N	106	81	97
Large	1997	Mean	71.7	3.93	100.0
		SD	3.470	0.322	
		N	3	3	2
	1999	Mean	77.2	5.08	83.3
		SD	4.595	0.636	
		N	16	10	12
	Both years	Mean	76.3	4.81	85.7
		SD	4.417	0.564	
		N	19	13	14

[1] default values for proportion female used in assessment were 0.5 for small and 0.8 for large from Sand Hill River, 1994-96.

Table 4b. River age distribution for Big Brook, Labrador in 1997 and 1999.

Year	Size		River age distribution 1	2	3	4	5	6	7	Total
1997	Small	Number	0	0	2	7	21	34	0	64
		Percent	0	0	3	11	33	53	0	
	Large	Number	0	0	0	0	3	0	0	3
		Percent	0	0	0	0	100	0	0	
1999	Small	Number	0	0	0	3	30	0	1	34
		Percent	0	0	0	9	88	0	3	
	Large	Number	0	0	0	6	5	3	0	14
		Percent	0	0	0	43	36	21	0	
1997 & 1999	Both	Number	0	0	2	16	59	37	1	115
		Percent	0	0	2	14	51	32	1	100

Table 5. Adult salmon returns, spawning escapment and egg depositions for Big Brook, Labrador in 1997 & 1999.

SPAWNING ESCAPEMENT $SE = TRR - (AC) - (HRM), HRM = (HRC * 0.1)$

SE= Spawning escapment
TRR= Total returns to river ($FC + AC_b + HRM_b$)
FC= Fence count
AC= Angling catch (retained)
HRC= Hook & release catch
HRM= Hook & release mortalities evaluated as 10% of HRC (HRC * 0.10)
a & b= subscripts denoting above and below the counting fence

		1997	1999	Average
TRR	Small	530	737	634
	Large	104	180	142
AC_a	Small	0	0	0
	Large	0	0	0
HRC_a	Small	0	0	0
	Large	0	0	0
AC_b	Small	73	49	61
	Large	2	13	8
HRC_b	Small	32	41	37
	Large	1	9	5
SE	Small	454	684	569
	Large	102	166	134

EGG DEPOSITION $ED = SE * PF * RF * FL$

ED= Egg deposition
SE= Spawning escapment
PF= Proportion females
RF= Relative fecundity (eggs/cm)
FL= Mean fork length of female salmon

	Year	1997	1999	AVERAGE
SE	Small	454	684	569
	Large	102	166	134
PF	Small	0.5	0.5	0.500
	Large	0.8	0.8	0.800
RF[1]	Small	68.2	68.2	68.2
	Large	67.5	67.5	67.5
FL[2]	Small	54	56.8	55.4
	Large	76.3	77.2	76.75
ED	Small	835627	1324632	1080130
	Large	419848	692438	556143
Total		1255476	2017070	1636273
Conservation requirements		5294160	5294160	5294160
% requirements met		24	38	31

[1] in the absence of fecundity values for Big Brook, Sand Hill River values were used
[2] due to low sample sizes mean fork lengths from 1997 & 1999 were used in 1997

STOCK: Big Brook (SFA 1) **Drainage area:** 793 km² (accessible)

CONSERVATION REQUIREMENT: x million eggs (~ x small salmon) calculated as fluvial area x 2.4 eggs/m²

Year	1994	1995	1996	1997	1998	1999 [2]	MIN [1]	MAX [1]
Total returns to river								
Small	-	-	-	530	-	737	530	737
Large	-	-	-	104	-	180	104	180
Recreational harvest (small salmon)								
Retained	62	92	38	73	54	49	-	412
Released	22	21	12	32	24	41	-	41
Recreational harvest (large salmon)								
Retained	10	5	5	2	4	13	-	172
Released	1	0	0	1	2	9	-	9
Spawners								
Small	-	-	-	454	-	684	454	684
Large	-	-	-	102	-	166	102	166
Egg conservation requirement								
% met	-	-	-	24	-	38	24	38

[1] Min and max are for the period of record since 1974.
[2] Preliminary

Data and methodology: A complete count of the adult salmon migration was obtained from a portable fish counting fence in 1997 and 1999. A hook-and-release mortality rate of 10% was used in the calculation of spawning escapement. Recreational data comes from DFO angling statistics collected from the outfitting camp on the river and are preliminary for 1999. Egg requirements for fluvial habitat were calculated similar to other rivers in Eastern Canada, however, due to a lack of information on lacustrine rearing in Labrador, lacustrine habitat was not included in the calculation.

State of the stock: The percentage of conservation requirements achieved remains low. However, there is some doubt as to the applicability of the Eastern Canada conservation requirement of 240 eggs per m2 in Labrador. Risk analysis indicated that 95th confidence intervals for conservation requirements were 27 to 51%.

Forecast: No forecast is available.